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L6: Entry 1 of 2

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TITLE: Personal computer card for collection of real-time biological data

Brief Summary Text (8):

Data acquisition cards have existed in the prior art for transferring electrical signals from a data sensor through the data acquisition card and into a personal computer. These data acquisitions cards have been configured into Personal Computer Memory Card International Association (PCMCIA) cards.

Brief Summary Text (9):

Prior art data acquisition cards are often configured to measure potential signals ranging from zero to ten volts, and are often configured with twelve bit accuracy. A typical prior art data acquisition card may comprise a 30 pin connector and a cable, which is connected to a connector board. The connector board allows a user to hook up various signals thereto. In addition to the relatively high-voltage signal range (zero to ten volts), low-accuracy (e.g. twelve bits), extra hardware (30 pin connector, cable, and a connector board), and additional optional hardware, these prior art data acquisition cards are configured with a plurality of inputs and outputs and, further, are not adapted to convert a personal computer into a powerful biological data signal collecting, processing, and monitoring system.

Brief Summary Text (11):

Another prior art device is disclosed in U.S. Pat. No. 5,549,115 to Morgan et al. The Morgan et al. patent generally discloses a PCMCIA format card which is adapted to perform as a data storage device, similarly to a floppy disc storage device. The PCMCIA format card of Morgan et al. is equipped with a real-time clock for providing time and date data to the host system, in order to synchronize the host system time with the time of which the data was actually acquired. The PCMCIA format card of Morgan et al. does not provide any means for real-time data collection and processing and, accordingly, is not suitable for converting a host PC computer into a real-time biological data signal collection, processing, and monitoring-system. The system of the Morgan et al. patent requires a separate dedicated computer device for acquiring the data, and-a separate personal computer device for processing the data at a later time.

Brief Summary Text (18):

The biological data receiver can be adapted to receive biological data from a pulse oximetry sensor, which is located externally of the portable biological data collection device. The biological data receiver can further be adapted to receive biological data from an ECG sensor. The biological data sensor is adapted to output low-amplitude signals on an order of one millivolt. The digitized data from the analog-to-digital converter preferably has a resolution greater than 12 bits and, preferably, has a resolution of 16 bits. The biological data sensor may further include a spirometer air tube.

Drawing Description Text (12):

FIG. 7 illustrates an articulated finger clip sensor according to the present invention;

Detailed Description Text (3):

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The PCMCIA format housing 12 of the real-time biological data processing PC card 10 is preferably configured to conform with PCMCIA dimensional standards. As presently preferred, the PCMCIA format housing has a width of approximately 2.95 inches. The PCMCIA format housing 12 preferably comprises a length of approximately 3.40 inches. The pressure transducer housing 14, according to the presently preferred embodiment, has dimensions which are larger than PCMCIA conventions permit. As presently embodied, the pressure transducer housing 14 comprises a height of approximately 1 inch. These enlarged dimensions of the pressure transducer housing 14 facilitate placement of biological sensor circuitry, such as, for example, a pressure transducer.

Detailed Description Text (5):

FIG. 2 illustrates a schematic block diagram of components associated with the real-time biological data processing PC card 10 and the host personal computer 27. The real-time biological data processing PC card 10 comprises a pressure sensor 32, an amplifier 34, an analog-to-digital converter 36, an analog-to-digital timing circuit 38, a storage buffer 41, and a PCMCIA interface 43. The flexible air passageway 18 connects the disposable spirometry mouthpiece 21 to the pressure sensor 32, and a conductor path 45 connects the pressure sensor 32 to the amplifier 34. The amplifier 34 is connected to the analog-to-digital converter 36 via a conductor path 47, and the analog-to-digital converter 36 is connected to the storage buffer 41 via a conductor path 50. A conductor path 52 connects the analog-to-digital converter 36 to the analog-to-digital timing circuit 38, and a conductor path 54 connects the analog-to-digital timing circuit 38 to the PCMCIA interface 43. The storage buffer 41 is connected to the PCMCIA interface 43 via a conductor path 51. Upon insertion of the real-time biological data processing PC card 10 into the PCMCIA format slot 30, the PCMCIA interface 43 is connected to a PCMCIA bus interface 58 via a bus 61.

Detailed Description Text (8):

Although the embodiment of FIG. 2 is shown comprising a pressure sensor 32 and a disposable spirometry mouthpiece 21, any biological data sensor and/or associated components may be incorporated into the real-time biological data processing PC card 10 in accordance with the present invention.

Detailed Description Text (9):

In one embodiment, each biological data sensor, having a different format of biological data, is configured in a separate real-time biological data processing PC card. The various real-time biological data processing PC cards are interchangeable, to thereby configure the host personal computer 27 into various real-time biological data collecting and processing modes. Alternatively, a single real-time biological data processing PC card 10 may be configured to accommodate one or more different types of biological data sensors. According to the present invention, various interchangeable real-time biological data processing PC cards can configure the host personal computer 27 into various collecting, processing, and monitoring modes, including spirometry, electrocardiography (including resting, 24-hour, stress testing, signal averaging, event ECG, and heart-rate variability), blood pressure, body temperature, electroencephalography (EEG), echocardiography, Doppler, pulse oximetry (SPO2), sleep analysis, tcPO2, tcPCO2, nitrogen dioxide, capnography, respiratory rate, pulse rate, polysomnography, carbon monoxide, gastroesophageal pH, hydrogen, nitric oxide, bio-impedance, glucometer, audiometry, plethysmograph, weight, electromyography, urometry, and tympanometry, for example. The term "bio-impedance" is intended to include the general meaning of the term "bio-impedance" and to also include body composition analysis, cardiac output or any other bio-impedance analysis. Other biological data may also be collected and processed by the host personal computer 27, after being configured by a corresponding real-time biological data processing PC card.

Detailed Description Text (10):

The real-time biological data processing PC card 10 shown in FIG. 2, which is

adapted for configuring the host personal computer 27 for spirometry procedures, receives a pressure signal from the mouth piece 21. The pressure sensor 32, which preferably comprises a pressure transducer, converts the pressure signal into an electrical signal, which is amplified by the amplifier 34. The analog-to-digital converter 36, which is timed by the analog-to-digital timing circuit 38, receives the amplified biological data from the amplifier 34, and digitizes the biological data. The analog-to-digital timing circuit 38 provides a timing signal, which facilitates sampling of the amplified biological data on the conductor path 47. This digitized biological data is output onto the conductor path 50. The storage buffer 41 receives the digitized biological data, and outputs this digitized biological data onto a conductor path 51, where the digitized biological data is made available to the PCMCIA interface 43. The storage buffer 41 preferably comprises a first in first out (FIFO) buffer, and may be omitted for simple configurations where buffering capabilities are not needed. The real-time biological data processing PC card 10 further comprises control circuitry, and the PCMCIA interface 43 preferably comprises input output (I/O) interface glue logic and an input output connector.

Detailed Description Text (13):

The biological data from the pressure sensor 32, after being processed by the amplifier 34 and the analog-to-digital converter 36, is preferably immediately transferred from the PCMCIA interface 43 of the real-time biological data processing PC card 10 to the PCMCIA interface 70 of the host personal computer 27. The host personal computer 27, having received designation data indicating that the real-time biological data processing PC card 10 is a spirometry real-time biological data processing PC card, is configured to function as a complete spirometry data collecting, processing, and monitoring device. For example, a volume-versus-time wave form or a flow-versus-volume curve may be displayed on the display 65, indicating the real-time biological data received by the pressure sensor 32. A number of other parameters, such as maximum exhale volume, maximum inhale volume, and maximum flow rate, to name a few, may also be shown on the display 65 of the host personal computer 27. This data also may be compiled and printed in a variety of analytical and comparative formats.

Detailed Description Text (17):

FIG. 5 illustrates a schematic block diagram of an embodiment of FIG. 4. Basically, data from a pulse oximeter sensor 105, such as the pulse oximeter clip 98 (FIG. 4), is fed to a pulse oximeter module 107 via a conductor path 110. As presently embodied, an optical coupler is positioned between the pulse oximeter finger clip 98 and a power source (not shown) connection of the real-time biological data processing PC card 10, to thereby prevent a patient from being shocked therefrom. Data from the pulse oximeter module 107 is then fed to the PCMCIA interface 43 via a conductor path 112. The pulse oximeter module 107 preferably comprises elements similar to the amplifier 34, the analog-to-digital converter 36, the analog-to-digital timing circuit 38, and the storage buffer 41. The elements of the pulse oximeter module 107 may be combined with or into the elements 34, 36, 38, 41 or, as presently embodied, maintained separately therefrom in the pulse oximeter module 107.

Detailed Description Text (18):

The host personal computer 27 may receive on a real-time basis, process, and monitor spirometry data and pulse oximetry data, either separately or simultaneously. The designation data, in the illustrated embodiment, indicates to the host personal computer 27 that the real-time biological data processing PC card 10 comprises both spirometry data and pulse oximetry data sensors. The pressure sensor 32 may alternatively be located on the disposable spirometry mouthpiece 21, as can the amplifier 34, the analog-to-digital converter 36, and the analog-to-digital timing circuitry 38, or any combination thereof. Any or all of these elements, in addition to the storage buffer 41, may be positioned on either the disposable spirometry mouthpiece 21, the pulse oximeter sensor 105, or the real-

time biological data processing PC card 10, or any combination thereof, or eliminated altogether. Since the present invention is not intended to be limited to PCMCIA interfaces 43, any circuitry capable of forwarding an analog signal to a host personal computer 27 could reduce the need for components within the real-time biological data processing PC card 10. The pulse oximeter sensor 105 and the pulse oximeter module 107 may be manufactured by Nonin.RTM. Medical, Inc., located in Plymouth, Minn. According to one embodiment, the pulse oximeter sensor 105 may be similar that in an 8600 portable pulse-oximeter, manufactured by Nonin.RTM. Medical, Inc.

Detailed Description Text (19):

FIG. 6a illustrates the main circuit board 118 of the presently preferred embodiment, generally corresponding to the elements 32-54 of FIG. 5. The main circuit board 118 is illustrated comprising a number of IC chips 121, a pressure input port 16, and a pressure sensor 32. A pulse oximetry module connector 125 accommodates a pulse oximetry module connector 127, which is illustrated in FIG. 6b. The pulse oximetry module connector 127 of FIG. 6b is electrically connected to a supplemental circuit board 130. The supplemental circuit board 130 generally corresponds to the pulse oximeter module 107 of FIG. 5.

Detailed Description Text (21):

FIG. 8 illustrates a schematic block diagram of a real-time biological data processing PC card 10a for collecting and forwarding on a real-time basis vitals data. In the embodiment of FIG. 8, like elements are designated with like reference numerals followed by the letter "a." Data from a pulse oximeter sensor 105a is fed to a pulse oximeter module 107a via a conductor path 110a. As presently embodied, an optical coupler is positioned between a pulse oximeter finger clip (not shown) and a power source (not shown) connection of the real-time biological data processing PC card 10a, to thereby prevent a patient from being shocked therefrom. Data from the pulse oximeter module 107a is then fed to the PCMCIA interface 43a via a conductor path 112a. The pulse oximeter module 107a may comprise conventional circuitry for processing data from the pulse oximeter sensor 105a, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the pulse oximeter module 107a may be combined with or into the elements of the temperature module 201 and the blood pressure module 203 or, as presently embodied, maintained separately therefrom in the pulse-oximeter module 107a.

Detailed Description Text (22):

Data from a temperature sensor 205, indicating a body temperature of a patient, is fed to the temperature module 201 via a conductor path 207. Data from the temperature module 201 is then fed to the PCMCIA interface 43a via a conductor path 209. The temperature module 201 may comprise conventional circuitry for processing data from the temperature sensor 205, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the temperature module 201 may be combined with or into the elements of the pulse oximeter module 107a and/or the elements of the blood pressure module 203 or, as presently embodied, maintained separately therefrom in the temperature module 201.

Detailed Description Text (23):

Data from a blood pressure sensor 211, indicating a blood pressure of a patient, is fed to the blood pressure module 203 via a conductor path 213. Data from the blood pressure module 203 is then fed to the PCMCIA interface 43a via a conductor path 215. The blood pressure sensor 211 preferably comprises a cuff with microphones as is known in the art. The blood pressure module 203 may comprise conventional circuitry for processing data from the blood pressure sensor 211, such as elements including an amplifier, an analog-to-digital converter, an analog-to-digital timing circuit, and a storage buffer. The elements of the blood pressure module 203 may be combined with or into the elements of the pulse oximeter module 107a and/or the

elements of the temperature module 201 or, as presently embodied, maintained separately therefrom in the blood pressure module 203.

Detailed Description Text (25):

Turning to FIG. 9, a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis ventilator operation data is shown. In the embodiment of FIG. 9, like elements are designated with like reference numerals followed by the letter "b." A pressure line 220 and flow line 222 are connected to monitor pressure and flow rate of a ventilator connected to a patient. The pressure line inputs pressure data from a hose of the ventilator to a pressure sensor 224 and, subsequently, to an amplifier 226. The flow line 222 are input into the pressure sensors 228 and the amplifier 230. An analog-to-digital converter 232 receives the signals from the amplifiers 226 and 230, and converts the signals to digital signals. The digital signals are forwarded to the PCMCIA interface 43b via a storage buffer 236.

Detailed Description Text (27):

FIG. 10 illustrates a schematic block diagram of a real-time biological data processing PC card for collecting and forwarding on a real-time basis, sleep-disorder related data. A chest band 240 is placed around a patient's chest to measure the patient's respiration rate, for example. Sensors on the chest band 240 measure movement of the patient's chest while the patient is sleeping for determining, for example, whether the patient is breathing through his or her nose and whether an obstruction is present. Data from sensors on the chest band 240 is input into a strain gauge 242 and subsequently amplified by an amplifier 244. A nasal canula/thermistor 246 measures breathing through a patient's nose, and the data therefrom is input into a pressure sensor 248 and subsequently amplified by the amplifier 250. A pulse oximetry sensor 253 measures the patient's pulse rate and/or blood-oxygen concentration. Data from the chest band 240 and the nasal canula/thermistor 246 is digitized by the analog-to-digital converter 260 and passed to the PCMCIA interface 43c via a storage buffer 263. Data from the pulse oximetry sensor 253 is similarly passed to the PCMCIA interface 43c after being processed by an oximetry module 266. The data from the chest band 240, the nasal canula/thermistor 246 and the pulse oximetry sensor 253 is transferred to the host personal computer 27 on a real-time basis, either separately, sequentially or simultaneously.

Detailed Description Text (31):

A real-time biological data processing PC card for collecting and forwarding on a real-time basis sleep-disorder related data including body motion and position, and ECG, is shown in FIG. 15. The apnea card circuitry generally corresponds to that disclosed in FIG. 10, and the PC card 10h further comprises a microphone module 326 for receiving sound signals from a microphone 328 and forwarding digitized signals on a real-time basis to the PCMCIA interface 43h. A limb motion module 331 inputs data from motion sensors 333. Data from the motion sensor or sensors 333 is processed by the limb motion module 331 and forwarded on a real-time basis to the PCMCIA interface 43h. Position data from a position sensor 336 is forwarded to the body position module 338, processed, and subsequently forwarded on a real-time basis to the PCMCIA interface 43h. The microphone 328 can be attached to a neck of a patient, for example, for providing information as to whether the patient is snoring. The motion sensor 333 may comprise an accelerometer, for example, and may be attached to a limb of a patient to determine limb and/or body motion. The position sensor 336 may comprise a mercury switch, for example, and may be attached to a portion of a patient to determine whether the patient is lying on his or her stomach or back, for example. An ECG sensor 341 may comprise one or two channels, for example, for inputting electrical information to the ECG module 343. Processed information from the ECG module 343 is subsequently forwarded on a real-time basis to the PCMCIA interface 43h.

Detailed Description Text (32):

The PC card 10i of FIG. 16 is similar to that depicted in FIG. 15, with additional EEG, EOG, and EMG components. An EEG sensor 348, an EOG sensor 350 and an EMG sensor 352 forward signals detected on a patient to an EEG module 354, an EOG module 356, and an EMG module 358, respectively, on a real-time basis. The EEG module 354, the EOG module 356 and the EMG module 358 forward processed data to the PCMCIA interface 43i on a real-time basis and, subsequently, as with the other embodiments of the present invention, the PCMCIA interface 43i preferably forwards the real-time data to the host personal computer 27 on a real-time basis.

Detailed Description Text (33):

Turning to FIG. 17, a real-time biological data processing PC card 10j inputs blood pressure data from a blood pressure sensor 370 on a real-time basis. The blood pressure sensor preferably comprises a blood pressure cuff with microphones. A blood pressure module 372 receives the data from the sensor 370 and forwards processed digitized data on a real-time basis to the PCMCIA interface 43j.

Detailed Description Text (34):

FIG. 18 illustrates a real-time biological data processing PC card for collecting and forwarding on a real-time basis birth procedure related data. A chest band 380 comprises a contraction sensor 382 and a fetus heart rate sensor 384. The contraction sensor 382 may comprise a pressure sensor, for example, which is adapted to be disposed on a woman's stomach via the chest band 380, and the fetus heart rate sensor 384 may comprise a microphone. An additional sensor (not shown) may also be incorporated for monitoring on a real-time basis the mother's heart rate. The additional sensor may comprise, for example, a pulse oximeter. Data from the contraction sensor 382 and the fetus heart rate sensor 384 is input into the pressure sensors and amplifiers 386, 388, 390, 392. An analog-to-digital converter 394 processes the information and outputs the information to the PCMCIA interface 43k via a storage buffer 397.

Detailed Description Text (35):

FIGS. 19, 20, and 21 illustrate non-invasive blood composition detection PC cards 10L, 10m and 10n, respectively, for collecting on a real-time basis biological data and forwarding the data on a real-time basis to a host personal computer 27. The blood glucose module 401 of the PC card 10L inputs blood glucose data from a non-invasive blood glucose sensor 403 on a real-time basis. The non-invasive blood glucose sensor 403 may comprise any conventional means for measuring a blood glucose concentration of a patient, such as, for example, a patch adapted to be attached to a person's skin or an optical measuring apparatus. A blood cholesterol module 406 of the PC card 10m (FIG. 20) inputs blood cholesterol data from a non-invasive blood cholesterol sensor 408. The non-invasive blood cholesterol sensor 408 may comprise any non-invasive blood-cholesterol measuring apparatus. The detection module 411 (FIG. 21) of the PC card 10n is adapted to receive a breath of a patient via a mouthpiece 413, and detect on a real-time basis gases including, oxygen, carbon dioxide, nitrogen and/or carbon monoxide. Each of the modules 401, 406 and 411 forwards processed sensor data on a real-time basis to the PCMCIA interfaces 43L, 43m and 43n, respectively. FIG. 22 illustrates a PC card 10o comprising an oxygen detector 415 for inputting breath from a mouthpiece 417 and forwarding processed data on a real-time basis to a PCMCIA interface 43o.

Detailed Description Text (37):

The PC card 10q illustrated in FIG. 24 collects heartbeat information on a real-time basis from a heartbeat sensor 430. The heartbeat information is processed via, an amplifier 434 and an analog-to-digital converter 436, and is passed on a real-time basis to the PCMCIA interface 43q via a storage buffer 438. The real-time heartbeat data can be monitored and manipulated on the personal computer 27.

Detailed Description Text (38):

The PC card 10r of FIG. 25 inputs data on a real-time basis from an ear probe 440 into a pressure sensor module 443, which processes the data and subsequently

outputs the processed data to the PCMCIA interface 43r on a real-time basis. The EUI probe 440 may comprise a hand-held wand for placement into the ear of a patient. The hand-held wand may comprise mechanical means for measuring the eardrum pressure or, alternatively, may comprise optical means for measuring an eardrum pressure of the patient as is well known in the art.

Detailed Description Text (42):

Information can be transmitted and received through the Internet connection 532 either on a real-time basis or, alternatively, at predetermined intervals. The set-top box 523 may be configured to automatically dial out and establish an Internet connection, and to transmit or receive real-time biological data over the Internet, at predetermined or user-defined intervals. A patient can conduct tests using one or more sensors, such as the sensors 535 and 537, and at the same time or at a later time, transmit the data to a doctor via the Internet connection 532. In addition to a set-top box 523, Internet telephones, personal computers, wireless Internet computers, network computers or other Internet "appliances" capable of sending real-time data over the Internet may be used. In one embodiment, game sets may be used to transmit or receive the real-time biological data over the Internet.

Detailed Description Text (43):

In modified configurations of the above-described embodiments, some or all of the circuitry and/or components for each of the modules on the personal computer cards can be placed within the host microprocessor system, so long as the card is able to input digital information to the host microprocessor system. Moreover, in other modified configurations circuitry and/or components for each of the modules on the personal computer cards can be placed on the biological data sensors themselves, in addition to or in the alternative to placement of the circuitry and/or components on the host microprocessor system. In embodiments where the signal or signals from the biological data sensor or sensors is simply digitized and forwarded to the host microprocessor system (personal computer, game set, set-top box, etc.) for subsequent processing and interpretation, the signal-conditioning circuitry can comprise the bare-essential elements, such as merely an analog-to-digital converter, for formatting the data from the biological data sensors and forwarding to the host microprocessor system.

CLAIMS:

1. A portable biological data collection device comprising: a biological data receiver for receiving biological data from a biological data sensor for producing a biological data signal; an amplifier for amplifying the biological data signal from the biological data receiver to produce an amplified signal; an analog-to-digital converter for digitizing the amplified signal to produce a digitized signal; and a personal computer card interface for relaying the digitized signal to a host computer on a real-time basis as the biological data is received by the biological data receiver, and for supplying electrical power from the host computer to the amplifier and the analog-to-digital converter.

14. A portable biological data collection comprising: a pressure sensor for receiving a pressure signal from a patient and converting the pressure signal into an electrical signal; an amplifier for and amplifying the electrical signal from the pressure sensor to produce an amplified signal; an analog-to-digital converter for digitizing the amplified signal to produce a digitized signal; and a personal computer card interface for relaying the digitized signal to a host computer on a real-time basis as the pressure signal is collected by the pressure sensor, and for supplying electrical power from the host computer to the amplifier and the analog-to-digital converter.

15. The portable biological data collection device of claim 14 further comprising a personal computer card housing, wherein the pressure sensor, the amplifier, the

analog-to-digital converter, and the personal computer card interface are disposed within the personal computer card housing.

17. The portable biological data collection device of claim 16 further comprising a personal computer card housing, wherein the pressure sensor, the amplifier, the analog-to-digital converter, analog-to-digital timing circuit, the storage buffer, and the personal computer card interface are disposed within the personal computer card housing.

18. A portable biological data collection device comprising: a biological data receiver for receiving biological data from a biological data sensor and producing a biological data signal; an amplifier for amplifying the biological data signal from the biological data receiver to produce an amplified signal; an analog-to-digital converter for digitizing the amplified signal to produce a digitized signal; and a personal computer card interface connectable to an external port of a host computer for relaying the digitized signal to the host computer on a real-time basis as the biological data is received by the biological data receiver, and for supplying electrical power from the host computer to the amplifier and the analog-to-digital converter.

20. A biological data collection system comprising: a host computer comprising an external computer card port; a portable biological data collection device comprising: a personal computer card housing; a biological data receiver disposed within the personal computer card housing for receiving biological data from a biological data sensor and producing a biological data signal; an amplifier disposed within the personal computer card housing for amplifying the biological data signal from the biological data receiver to produce an amplified signal; an analog-to-digital converter disposed within the personal computer card housing for digitizing the amplified signal to produce a digitized signal; and a personal computer card interface disposed within the personal computer card housing and connectable to the external computer card port of a host computer to supply electrical power from the host computer to the amplifier and the analog-to-digital converter; and software installed in the host computer for allowing the personal computer card interface to relay the digitized signal to the host computer on a real-time basis as the biological data is received by the biological data receiver.

26. A portable biological data collection device comprising: a biological data receiver housing; a personal computer card interface housing adapted to mate with an external personal computer card port of a host computer; a biological data receiver disposed within the biological data receiver housing for receiving biological data from a biological data sensor and producing a biological data signal; an amplifier disposed within the biological data receiver housing for amplifying the biological data signal from the biological data receiver to produce an amplified signal; an analog-to-digital converter disposed within the personal computer card interface housing for digitizing the amplified signal to produce a digitized signal; and a personal computer card interface disposed within the personal computer card interface housing for relaying the digitized signal to the host computer on a real-time basis as the biological data is received by the biological data receiver, and supplying electrical power from the host computer to the amplifier and the analog-to-digital converter.